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ABSTRACT

Previous research has examined whether manipulation of one environmental element, such as sound, significantly affected group norms for achievement. This investigation examined the relation of preferred and actual acoustic environment on reading performance. Subjects were 32 male and 32 female sixth-graders from a suburban school in New York State who had indicated, on the Learning Style Inventory of R. Dunn and others (1979), a strong preference for either extreme quiet or extreme noise when studying or learning. Half were given a reading test in the acoustic environment (loud or quiet) that matched their identified preferences for sound; half were tested in the mismatched condition. Subjects were administered the Gates MacGinitie Reading Tests and a semantic differential scale designed to measure student attitudes when tested in matched/mismatched acoustic environments. Students performed best in the environment that matched their preferences. The implications for the classroom of student preference and environmental noise are discussed. The biological basis of individual acoustic requirements is considered. Environmental elements in meeting student preference can be responded to in the classroom at virtually no cost. There are 39 references and a 17-item supplemental bibliography. (SLD)

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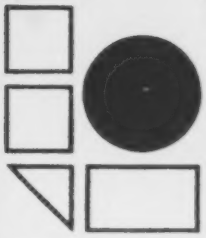

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SOUND: ONE LEARNING STYLE CHARACTERISTIC

By

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Sound: One Learning Style Characteristic

By

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Ask any group of 50 or more adults, and you will find that some must have absolute quiet when concentrating on new and difficult tasks, others are capable of blocking out sound; they hear nothing once they become absorbed; and others must have sound of one type or another; sometimes it is music, occasionally it is the surging of water, and once in a while, people report that they need the soothing noise of a hairblower, a carpet vacuum, or an overhead bulb. That sound has obvious face validity is unquestionable; that it affects different people differently is another accepted fact. In light of the common understanding of that element, it is perplexing that until this decade few people assessed its effects on achievement in ways that might have contributed substantially to the improvement of instructional environments.

Part of the problem was that most research conducted during the 1970's compared large group reactions to a given variable; thus, everything was more effective for some and less effective for others. That type of design is inappropriate for determining the effect of providing congruent/incongruent conditions for people with various learning style characteristics; for such experimentation, Aptitude Treatment Interaction studies are better. When testing whole group reactions without first identifying individual learning style preferences for the variable being examined, it is virtually certain that conflicting data will be yielded. For example, in previous investigations when group reactions to

sound were sought without having identified the strength or absence of individual preferences or characteristics, noise either improved (Lane, 1976; Samtur, 1969), impaired (Turnure, 1970; Wyon, 1970), or left unchanged (Weinstein & Weinstein, 1978; Slater, 1968) student achievement levels. Such studies also concluded that boys generally appeared to be more tolerant of noise than girls (Ollilla & Chamberlain, 1975; Christie & Glichman, 1980) - verifying that those researchers enjoyed only scant knowledge of learning style and how/why noise affects the sexes differently.

Thus, although a review of the literature on sound is included herein, it is important that the field be aware that many investigations reflect inappropriate designs and that their findings suffer from misinterpretation of the data. For example, investigators who reported that boys are more tolerant of noise than girls reached those conclusions because many males appeared to ignore environmental sounds as they were studying, concentrating or performing; many females, on the other hand, evidenced extreme irritation, increasing anxiety and/or an inability to concentrate with noise in the environment. Results were given in percentages of the entire population, almost certainly ignoring that some girls must have been oblivious to the sounds and that some boys must have found them enervating. That data was not provided. The investigators appeared to have been oblivious to the studies that revealed that girls become auditory earlier than boys, leading to their better ability to hear, retain by hearing, discriminate among sounds, and, thus, speak and read earlier and often better than most boys (Restak, 1979; Pizzo, 1981). Girls are more disturbed by sounds because they hear them more distinctly; boys, being more visual than auditory, are not as impaired by environmental noises because they are not as sound-sensitive as females. They thus are not as aware of sound as girls. On the other hand, despite that sex differentiation, some boys are as sound-sensitive as girls

generally appear to be, and many girls are as unaffected by noise as the majority of males. Thus, when designing an instructional environment, it is important to know which children of both sexes need to be located in areas away from the usual classroom activities so that they can be spared the physical tension that accompanies bombardment by noise when one is sound-sensitive. Conversely, youngsters who appear to be less aware of sounds - including their teacher's voice - can be placed in close proximity to the section of the room where the teacher generally stands when addressing the group. Teachers, too, can be made aware of those youngsters who are likely to "block out" directions merely because they are better able to do so biologically than many of their classmates.

Review of the Literature on Sound

The existence of individual preferences for or sensitivity to sound appears not to have been tested scientifically prior to Pizzo (1981). That investigation was conducted to determine whether the assignment of subjects to acoustic environments congruent with their learning style predispositions for sound would affect significantly both their reading achievement and attitudes. Before that time, only limited data were available concerning the effects of acoustic environments on the school performances of students. Those studies that had been reported were designed to examine the differences between groups of students, rather than the interaction between individual subjects and particular acoustic conditions.

The data of one of the earliest of those investigations revealed that students learned best with a moderate amount of sound present when compared with either no noise or excessive noise (McCarthy, 1968). In that experiment, 80 sixth grade students who

had achieved the highest mean scores on the Metropolitan Reading Achievement Test - Form D , were randomly assigned to accomplish either easy or difficult tasks within each of five decibel level groups, as well as in a no noise situation. Significant differences were evidenced between the scores obtained in the no noise, high noise and moderate noise conditions. As indicated above, student performance was highest when working in the moderate range.

Slater (1968) was one of the first researchers to investigate the effects of classroom noise upon written performance. The findings of that experiment indicated that no significant differences resulted as an outgrowth of sex, and no interaction occurred related to writing speed or accuracy. That study was conducted with 129 seventh graders. The raw score from Part 1 of an alternate form of the STEP Reading Test was used as a correlation of I.Q., socioeconomic status and achievement to equate the groups. Following the testing period, the Sarason Test Anxiety Scale For Children and two questionnaires were administered. The data from those instruments were used to determine the relationships among individual differences, anxiety and the effects of noise.

Another early investigation by Samatur (1969), attempted to determine the effect of constant and fluctuating noise on the reading performance of 25 third graders on a complex reading test. It further sought to determine how noise affected answers to the easy and difficult problems included in the reading test. The Metropolitan Reading Test of Achievement served as the pretest/posttest; Form A was administered in a quiet condition, Form B in a constant noise condition, and Form C in an intermittent noise condition. The results of that experiment surprisingly revealed that both boys' and girls' performances improved under noisy conditions. Those findings conflict with many others (Price, 1980; Restak, 1979).

Contradictory evidence concerning the performance of students in noisy conditions also was revealed by Wyon (1970). One hundred and ten 12-year-olds worked while exposed to an unfamiliar and unpredictable noise climate. Observations of individual students from behind one-way mirrors indicated that "significantly more children appeared to be working with obvious effort in the noise condition, and significantly more were distracted by others and stopped working" (p. 610). Not only did the findings of that investigation indicate significant decrements in student performance in the noisy condition, but it also evidenced that on a test of recognition memory the noise-exposed classes were significantly less confident and less consistent in their answers.

Another researcher concerned with the effects of auditory stimulation of the level and kind likely to be found in a child's classroom environment, investigated the performance of 40 third and 40 sixth graders on a series of self-paced arithmetic tasks (Kassinove, 1972). No significant effects were evidenced as a function of meaningful auditory stimulation. However, obvious individual differences were observed between the behaviors of students performing the experimental task in both the quiet and noisy conditions. Kassinove stated: "In the noise conditions, some children appeared to be distracted by noise; however, an equal amount of distraction by non noise environmental stimuli appeared to occur in the quiet condition" (p. 529).

Nober (1973) classified 39 early elementary children - 23 males and 16 females - as either normal, speech defective or reading retarded. In that experiment, each student was administered both Forms I and II of the Wepman Auditory Discrimination Test in both the quiet and the noisy listening conditions.

The findings of that experiment indicated that only the reading deficient subjects performed at significantly lower levels in noise than in quiet. That investigator concluded:

> The results of this study support the plethora of auditory research which clearly demonstrates that auditory perception is adversely affected by noise. Indeed, noise is used to pre-empt hearing in a variety of hearing tests by audiologists. In testing this specific aspect of auditory perception, it has been possible to show that a well-constructed test such as the Wepman, standardized in a quiet environment, and universally used as an index of a child's auditory discrimination performance, does not serve as a valid index for a given child's auditory discrimination performance within the classroom setting, where the listening-learning activities occur. (p. 291).

The findings of several studies suggested that auditory discrimination ability is developmental and improves from approximately age four onward - where the normative data begin - to approximately age 25 and thereafter declines. Specifically, the performance of children of about 10 years of age and younger is affected more by the presence of competing noise - cafeteria sounds or monosyllabic words - than the performance of older children and adults (Goldman, Fristoe & Woodcock, 1970). Marsh (1973) found that performance clearly improved from age five to nine. Two hundred and ten subjects - 104 females and 106 males - comprised the sample population

in that investigation of the developmental aspects of performance on tasks constructed to measure auditory figure-ground perception. The results verified a developmental trend in auditory figure-ground ability; a significant decrease in errors was substantiated on the total Auditory Figure-Ground Test as age increased; the subtest correlations also were significantly related to age.

Aspects of auditory development were also studied by Cohen, Glass and Singer (1973) who suggested that the development of important human skills was affected by the noise levels in selected home environments. Those investigators hypothesized an association between home noise levels and the acquisition of auditory discrimination and reading skills. Fifty-four elementary school children in grades two through five, living in four, 32-floor apartment buildings adjacent to a heavily traveled expressway, were tested on the Wepman Auditory Discrimination Test and the Metropolitan Reading Achievement Test. Correlations were significant between scores on the Wepman Test of Auditory Discrimination and floor level, and between auditory discrimination and percentile scores on the MRAT, but only for the group of children who had lived in the apartment complex for four years or longer.

One year later, Miller (1974) noted that while free and easy speech communication probably is essential for the development of social relations and self-respect among adults, for very young children who gradually induce their knowledge of language and its subtleties from speech, an additional problem may exist. Because their knowledge of language is still developing, children probably have more difficulty understanding speech in the midst of noise than do adults. He stated:

> Because noise can reduce the amount of speech used at home, in the yard, or in the playground, and because noise can make speech difficult to understand, it is possible, though unproven, that the language development of early childhood might be adversely affected. From this, difficulty in learning language and learning to read may ensue. (p. 743).

Although Miller emphasized that noise must be severe to produce those effects, he concluded that such conditions do exist in some residences in urban areas, particularly near freeways.

The effects of environmental noise were also examined by Bronzaft and McCarthy (1975). They investigated the relationship between high-intensity, unpredictable sounds and reading deficits, as well as the experiential effect of such noise in a classroom environment. The subjects participating in that study were 161 second, fourth and sixth graders attending an urban school located approximately 220 feet away from an elevated subway track. Eighty trains passed along the track each weekday between the hours of 9:00 a.m. and 3:00 p.m. A questionnaire was administered to the subjects to determine whether they perceived the noise emanating from the passing trains and other sources of disturbance as interfering with their school work. Metropolitan Reading Achievement Test scores were obtained from the subjects' school records for a period of four years and were used to compare matched classes on the quiet and noisy sides of the building. Based on a ten-month school year, the scores of 9 of the 10 classes on the noisy side of the building evidenced a performance level of three to four months lower than their counterparts located on the quiet side. No sex differences were observed.

Sex differences, however, were evidenced by selected studies which indicated that males evidenced a higher tolerance for noise than did females. One such investigation by Ollilla and Chamberlain (1975) examined the influence of classroom noise and two methods or presentation upon the rate at which kindergarten children learned four dissimilar words. A total of 120 subjects were selected from nine kindergartens in three Canadian schools. Fifteen boys and 15 girls were assigned separately to each of the two sound conditions: (a) noise - 70 dBA, and (b) no noise, and to two methods of presentation: (a) word-alone, and (b) word-object, for a total of eight groups.

The findings revealed a significant difference favoring the girls trained by the word-alone method of presentation under the no noise condition. No sex differences were observed as a function of presentation method alone; however, the combination of word-object presentation and classroom noise significantly depressed the performance of girls; but not that of boys, suggesting that girls appear to be more sound-sensitive. In general, the performance of boys was unaffected by noise irrespective of the presentation method.

Three years later, those same two researchers evidenced that girls learned significantly more dissimilar words in a quiet condition with a word-alone method of presentation; however, findings substantiated that the performance of boys again was unaffected by the presence of sounds, irrespective of the method of presentation (Ollilla and Chamberlain, 1978). Also concerned with the basis of sex difference, Miller (1974) explored that topic with 25 male and 25 female university subjects. The results of that

experiment indicated that women had a lower tolerance for high-intensity sounds corroborating Ollilla and Chamberlain's data (1978); men were able to tolerate significantly higher sound levels.

Other investigations attempted to determine whether a positive relationship existed between sound, achievement and student feelings. Lane (1976) was concerned with the effects of three types of background music on mathematics achievement, task-relevant behavior, reported feelings of tiredness and pleasantness and teacher respect. Sixty-nine subjects- 36 boys and 33 girls - eight through nine years of age - comprised the sample for that investigation. Three parents, trained in behavioral observation techniques, monitored children's classroom behaviors for a forty-minute period daily. During that interval, students worked on structured mathematics assignments. A time-sampling technique was utilized to collect data on task-relevant behavior and to record sound-level meter readings.

The results of that investigation indicated that soft background music increased mathematics achievement in proportion to apptitude. Students in classrooms with music also reported feeling more rested and pleasant.

The paucity of research data on the developmental nature of children's ability to discriminate among speech patterns in the presence of noise - signal/noise - provided the impetus for another area of exploration designed by Larson and Petersen (1978). The speech discrimination performances of 40 young children were compared with those of 40 young adults. The children ranged from 5-1/2 to 6-1/2 years in age. All subjects were administered an audiological test and evidenced normal hearing acuity. They then

were tested under four listening conditions: first in quiet, and then with three different levels of interfering noise.

That investigation revealed the range of scores in quiet the same for children and adults - 88 to 100% - and the differences in mean scores only 2% lower for the children than for the adults. However, as noise was introduced via speech, intelligibility decreased for both age groups, with more significant deterioration evidenced among the scores of children. When even the lowest level of noise was presented, the children's mean score was 17% lower than in the quiet condition; the adults' mean score indicated a reduction of only 7% in noise. In the poorest of listening conditions the children's mean discrimination score was 20% below the adult mean.

Application of the auditory evidence available led researchers to further investigate the impact of sound on children in instructional environments. To determine whether the reading performance of students attending an open space school would be adversely affected by naturally occurring classroom noise, Weinstein and Weinstein (1978) employed as subjects, 60 fourth graders - 28 boys and 32 girls - assigned to three equally-sized homeroom classes within one large classroom. Each class contained 18, 22 and 20 students previously classified as low, average and high ability readers respectively by their teachers. The dependent variables employed in that experiment were six tests, of equal difficulty for each ability level, each comprised of twenty questions selected at random from Boning's Specific Skills Series, Getting the Main Idea and Using the Context. Those results verified that noise caused no significant effect on either accuracy or reading speed.

Conversely, another experimental study designed to examine the effects of classroom noise on intellectual performance conducted by Christie and Glickman (1980) suggested that students' performance on many classroom tasks varied as a function of classroom noise, and that sound did not affect the performance of all youngsters in the same manner. An optimal environment for boys, who evidenced a higher tolerance for sound according to those authors, appeared to be relatively noisy, while girls tended to perform better in quiet, corroborating previous findings suggesting that girls are more sound-sensitive or auditory than boys.

One hundred and fifty-six students were selected to participate in that experiment - 72 first graders, 36 third graders and 48 fifth graders. At each grade level the subjects were divided into two groups and assigned randomly to the noisy - or relatively quiet - environment; males and females were equally represented at each grade level and in each condition. Raven's Standard Progressive Matrices served as the task and was administered to three or four children who were tested simultaneously in the school library.

A three-way analysis of variance for unequal n's was applied to the data. A significant main effect was evidenced for grade; older children exhibited higher scores on the matrix task than younger children. The application of Cicchetti's posttest (1972) further indicated a significant interaction between noise and sex - males at all grade levels consistently exhibited significantly higher scores in a noisy environment (suggesting an ability to block out sound), while females consistently scored higher in a quiet environment.

At present, the literature reveals few studies concerned with the short- and long-term effects of noise on the development of speech, language, listening and related skills, such as reading, among children. Although Ollilla and Chamberlain (1975) suggested that classroom teachers be made aware of the possible interrelationship between classroom noise levels and instructional methods, it appears that studies conducted with respect to sex differences verify that the individual - rather than the group - determines the extent to which sound: (a) becomes a distractor; (b) is ignored; or (c) facilitates concentration in the instructional environment.

In 1977, Perry examined the effects of three noise levels - 0 to 10 dB, 40 to 50 dB and 70 to 80 dB - designated as low, average and high-noise conditions, on the task performance of fifth-grade students with average aptitude and mathematical ability. Seventy-two students participated in that study - 18 worked in isolation, and 54 worked in small groups of three in an experimental setting.

Subjects were assigned to groups on the basis of their preferences for: (a) working alone or with a friend, and (b) working in a low, average or high-noise environment when doing very important homework. Three worksheet forms using three row, six-digit addition problems of the same difficulty were employed as tasks. All students were administered each of the three worksheet task forms and were exposed to each of the three noise levels for 10 minutes, with five minute rest periods between each task. Task performance variables of time taken to complete the task and the number of items answered correctly were analyzed.

The findings of that investigation indicated no significant differences among the mean scores of students in the low, average and high-noise conditions. However,

students working in isolation required a longer period of time to complete the task in the low-noise level conditions than students working in small groups. Further, a significant difference was evidenced between the posttest noise-level preferences expressed by students who had worked in isolation, and those expressed by students who had worked in small groups.

That investigation, however, can be criticized on the following methodological grounds: (a) no reliability data were provided concerning the questions used to determine students' sociological preferences, and (b) no validity and reliability data were available for the arithmetic tasks used as measures of performance.

The effects of noise on the performance of adults engaged in nonauditory tasks were studied both in laboratory and work situations. A review of that research indicated that when mental or motor tasks did not involve auditory signals the effects of noise on performance were difficult to assess. The complexity of human behavior and differences among individuals, particularly without prior identification of individual predispositions to sound, appeared to have precluded definitive conclusions concerning exactly how noise influenced the performance of different kinds of people on different types of tasks. Nevertheless, certain general conclusions emerged:

(1) Steady noise with special meaning did not appear to interfere with human performance that did not include auditory components, unless the A-weighted noise level exceeded approximately 90 dB (Hockey, 1970a);

(2) Irregular bursts of noise were more disruptive than steady noise (Finkelman & Glass, 1970);

(3) Noise did not seem to influence the overall rate of work, but high levels of noise may have increased the variability of the rate of work - noise pauses followed by compensating increased in work rate (Weinstein, 1974; 1977);

(4) Noise was more likely to reduce the accuracy of work than to reduce the total quantity of work (Weinstein, 1977);

(5) Complex tasks were more likely to be adversely influenced by noise than simple tasks (Broadbent, 1958; Miller, 1974); and

(6) Even when a person maintained high performance in noise as opposed to quiet, there may have been a psychological cost in terms of increased fatigue evidenced after completion of the task and reduced capacity to meet additional demands (Glass, Singer & Friedman, 1969; Finkelman & Glass, 1970, & Weinstein, 1977).

Therefore, while the limited data available with respect to children did not permit Mills to make a firm generalization (1971), he suggested that: "One might predict that, as for adults, the effects of noise on performance are very complicated and depend upon the spectrum and level of the noise, temporal aspects of the noise, psychological responses to the noise and the nature and complexity of the task" (p. 774).

Finally, in his book, The Brain: The Last Frontier, Restak (1978) described brain research which had evidenced that many behavioral disparities between males and females were based on differences in biologically inherent brain functioning that are unlikely to be modified by cultural factors. That data, according to Restak, resulted from continuing direct observation of male and female infants. Female

infants were found to be more sensitive to sounds - particularly to their mothers' voices - from birth. Laboratory experiments further indicated that if the sound of the mother's voice was displaced to another part of the room, female babies reacted while male babies usually seemed oblivious to that displacement. Female babies also were observed to be more startled by loud noises. Restak further commented that, "In fact, their enhanced hearing performance persists through life, with females experiencing a fall-off in hearing much later than males". (p. 198).

The First Experimental Research Concerning Individual Learning Style Preferences for Sound Versus Quiet and Academic Achievement

As reported earlier, previous research examined whether manipulation of a single element significantly affected group norms; the concept of learning style rejects that type of statistical design and substitutes experimentation concerning how each individual achieves better, more easily, and/or retains longer when selected strategies or resources that complement a specific trait are provided. For example, when group reactions to a quiet - as opposed to a noisy - acoustic environment originally were sought, conflicting data were obtained. Noise either improved (Lane, 1976; Samtur, 1969), impaired (Turnure, 1970; Wyon, 1970), or left unchanged (Weinstein & Weinstein, 1978; Slater, 1968) student achievement levels. The findings of such studies also indicated that boys generally appeared to be more tolerant of noise than girls (Ollilla & Chamberlain, 1975; Christie & Glickman, 1980). However, when Pizzo (1981, 1982) administered the Learning Style Inventory to all the sixth graders in an affluent, suburban New York

school district, the data were clear; almost nine percent of the individuals in that population evidenced a strong preference for either extreme quiet or noise when concentrating, studying or learning.

Based on those LSI scores, 32 males and 32 females identified as having strong preferences for either quiet or sound were assigned randomly and equally to one of two experimental classrooms - quiet and noisy. Half were tested in the acoustic environment that matched their identified preference for sound; half were tested in the mismatched condition. Decibel levels in the quiet and noisy classrooms ranged between 40-45 dB and 75-80 dB respectively.

Subjects in both classrooms were administered the Gates MacGinite Reading Tests and a semantic differential scale Pizzo developed to measure student attitudes when tested in matched/mismatched acoustic environments.

The results of that investigation revealed that: (a) students with a preference for quiet performed best in a quiet acoustic environment, and (b) students with a preference for sound performed best in a noisy acoustic environment - both at the .01 level; (c) students in an environment that complemented their learning style preference also evidenced statistically higher attitudinal scores than their mismatched peers at the .01 level; and (d) a mismatched environment not only impaired the quality of student reading achievement, but also detrimentally affected students' attitudes toward their own intellectual ability, physical and emotional strength and emotional stability.

Those findings represented a major breakthrough in acoustic research - particularly since a review of the literature had revealed that no previous investigation had utilized individuals' learning styles as the basis for assignment to experimental conditions. Former studies had compared only the achievement of groups of students, rather than of individuals with distinct preferences for either quiet or sound. Thus, previous data appear to have been influenced by at least one important omission in design.

Classroom Implications of the Pizzo Findings Concerning Individual Sound Preferences

Changing a person's processing style may be impossible if it is genetically imposed as suggested by Restak (1979); Thies (1979, 1983) and Schmeck and Lockhart (1983); changing a classroom environment to respond to students' physiological styles is not only sensible, it is cost efficient and practical (Alloway, 1982). Furthermore, it produces statistically improved test scores among elementary and secondary students (Della Valle, 1984; Krimsky, 1982; Murrain, 1983; Pizzo, 1981; Shea, 1983) and has been adopted widely by business in both the United States (Makower, 1983) and in England (Trichauer, 1978). If matching is to be undertaken, certainly assigning students to instructional settings that complement their biologically imposed characteristics would appear to be an intelligent starting point.

Individual acoustic requirements can be provided in a conventional classroom merely by student:

1. placement away from traffic and activity patterns;

2. use of soft cotton, rubber ear plugs or joggers' ear muffs to limit the number and type of sounds heard;
3. listening stations for the few who need music when learning; and
4. use of donated, last year's carpeting samples from local stores.

The latter are deductible under Internal Revenue guidelines as contributions to eleemosynary organizations - which is what schools are!

Summary

Sound appears to be one element of learning style since experimental research verifies that students tested in an acoustically responsive environment achieve significantly higher scores than in a disonant condition (Pizzo, 1981). When an element is a strong preference for students, it is extremely difficult, if not impossible, to overcome because learning style is biological; it has its basis in the structure of the individual's neural organization and personality (National Task Force, 1983). The environmental elements (Dunn & Dunn, 1978) can be responded to easily by any concerned teacher at virtually no cost. It is the very least that our professional responsibilities require of us.

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